

In the Claims:

1. (Currently Amended) An object recognition system mounted on a vehicle, comprising:

one or more sensors for capturing an image of a road surface;
measuring means for dividing the image into a plurality of windows and measuring distance to the road surface for each of the plurality of the windows;
means for storing, for each of the plurality of the windows, estimated distance to the road surface;

means for comparing, for each of the plurality of the windows, the measured distance with the estimated distance to determine if the measured distance belongs to the road surface;

ALP inclination estimation means for estimating a relative inclination of the road surface against the vehicle based on the measured distances that are determined to be of the road surface; and

means for modifying the estimated distances based on the inclination estimated by said inclination estimation means.

~~judging means for judging, for each of the plurality of windows, based on the estimated inclination, whether the object is an obstacle or the road surface; and~~

~~recognition means for recognizing the object based on a result from the judging means.~~

2. (Original) The system of Claim 1 wherein said inclination estimation means comprises pitch estimating means for estimating slope of pitching of the vehicle as it travels and roll estimating means for estimating slope of roll of the vehicle as it travels.

3. (Original) The system of Claim 2, further comprising:

distance estimating means for estimating the distance from each window to the road surface based on the slope of the pitch estimated by the pitch estimating means and the slope of the roll estimated by the roll estimating means; and

estimated distance memory for storing for each of the windows the distance estimated by said distance estimating means.

4. (Currently Amended) The system of Claim 3 ~~wherein said~~ further comprising judging means for comparinges for each window the distance measured by said measuring means for each window and the estimated distance estimated by said distance estimating means to determine relative to each window represents the road surface; and recognition means for recognizing the object based on a result from the judging means.

5. (Original) The system of Claim 4 wherein said judging means extracts windows that represent object other than the road surface for transfer to said recognition means.

6. (Original) The system of Claim 2 wherein said pitch estimating means determines pitch angle \emptyset according to the equation;

$$\tan \emptyset = \frac{n \sum Z_i Y_i - \sum Z_i \sum Y_i}{n \sum Z_i^2 - (\sum Z_i)^2}$$

where Y_i and Z_i are y-axis and z-axis positions respectively of the i-th sample and n indicates the number of samples, y-axis being the direction of height of the vehicle and z-axis being the direction of travel of the vehicle.

7. (Original) The system of Claim 2, wherein said roll estimating means determines roll angle or α according to the equation;

$$\tan \alpha = \frac{n \sum Z_i Y_i - \sum X_i \sum Y_i}{n \sum X_i^2 - (\sum X_i)^2}$$

where X_i and Y_i are x-axis and y-axis positions respectively of the i-th sample and n indicates the number of samples, x-axis being the direction of breadth of the vehicle and y-axis being the direction of height of the vehicle.

8. (Currently Amended) An object recognition system mounted on a vehicle, comprising:

one or more sensors for capturing an image of an object;

measuring means for measuring a distance to the road surface for each of a plurality of windows dividing the image;

means for storing, for each of the plurality of the windows, estimated distance to the road surface;

means for comparing, for each of the plurality of the windows, the measured distance with the estimated distance to determine if the measured distance belongs to the road surface;

inclination estimation means for estimating a relative inclination of the road surface against the vehicle based on the plurality of distances that are determined to be of the road surface; and

correction means for correcting positioning error of said one or more sensors based on ~~an~~ a long time average of the estimated inclination.

9. (Currently Amended) The system of claim 8 wherein said inclination estimation means comprises:

pitch estimating means for estimating slope of pitching of the vehicle as it travels; and

roll estimating means for estimating slope of roll of the vehicle as it travels;

wherein said correction means comprises:

distance estimating means for estimating the distance from each window to the road surface based on the slope of pitch estimated by the pitch estimating means and the slope of roll estimated by the roll estimating means;

estimated distance memory for storing for each of the windows the distance estimated by said distance estimating means;

wherein ~~the content of~~ data held by said distance memory is made to change at a large time constant such that secular change of positioning of said one or more sensors is corrected.

10. (Original) The system of Claim 8 wherein said correction means comprises:
pitch estimating means for estimating slope of pitching of the vehicle as it travels;
roll estimating means for estimating slope of roll of the vehicle as it travels; and
sensor position estimating means for estimating deviation of the position of said one or more sensors from their specified position based on the pitch estimated by said pitch estimating means and the roll estimated by said roll estimating means;

wherein the deviation of the position of said one or more sensors is determined based on moving average of the estimated pitch and the estimated roll.

11. (Currently Amended) An object recognition method for recognizing an object in front of a vehicle, comprising steps of:

capturing an image in front of the vehicle;

measuring a distance to the road surface for each of a plurality of windows

dividing the image and thereby obtaining a plurality of distances;

storing, for each of the plurality of the windows, estimated distance to the road surface;

comparing, for each of the plurality of the windows, the measured distance with the estimated distance to determine if the measured distance belongs to the road surface;

estimating a relative inclination of the road surface against the vehicle based on the ~~plurality of distances;~~ measured distances that are determined to be of the road surface; and

modifying the estimated distances based on the estimated relative inclination.

~~judging, for each of the plurality of windows, based on the estimated inclination, whether the object is an obstacle or the road surface and thereby giving a judgment result; and~~

~~recognizing the object based on the judgment result.~~

ALL
CON'

12. (Original) The method of Claim 11, further comprising a step, performed between the steps of measuring and inclination estimation, of:

extracting windows having captured the road surface from the plurality of windows, and wherein the step of inclination estimation estimates the inclination utilizing distances of the plurality of distances, the utilized distances corresponding to the extracted windows.

13. (Original) The method of Claim 12, further comprising a step of:

estimating distances to the road surface respectively for the plurality of windows based on the estimated inclination, wherein windows are extracted based on the estimated distances in the step of extraction.

14. (Currently Amended) The method of Claim 11, further comprising the steps of ~~wherein:~~

judging, for each of the plurality of windows, based on the estimated inclination, whether the object is an obstacle or the road surface and thereby giving a judgment result;

recognizing the object based on the judgment result;

obtaining, when the object has been judged as an obstacle in the judging step, a relative speed and a relative speed and a relative distance between the vehicle and the obstacle utilizing the image;

~~the recognition step further obtains, when the object has been judged as an obstacle in the judging step, a relative speed and a relative speed and a relative distance between the vehicle and the obstacle utilizing the image, and further comprising steps of:~~

sensing possible collision with the obstacle based on at least one of the relative speed and the relative distance; and

performing collision avoidance action.

15. (Currently Amended) An object recognition system mounted on a vehicle, comprising:

a camera for capturing an image of an object; and

2-16
CON-1

a controller configured to performing the functions of;
dividing the image into a plurality of windows,
measuring a distance to the road surface for each of the plurality of windows and
thereby obtaining a plurality of distances,
storing, for each of the plurality of the windows, estimated distance to the road
surface;
comparing, for each of the plurality of the windows, the measured distance with
the estimated distance to determine if the measured distance belongs to the road surface;
estimating a relative inclination of the road surface against the vehicle based on
the plurality of distances measured distances that are determined to be of the road
surface, and
modifying the estimated distances based on the estimated relative inclination.
~~judging, for each of the plurality of windows, based on the estimated inclination,~~
~~whether the object is an obstacle or the road surface and thereby obtaining a judgment~~
~~result, and~~
~~recognizing the object based on the judgment result.~~

1-16
CON-1

16. (Original) The system of Claim 15, wherein the controller further performs functions of:

extracting windows having captured the road surface from the plurality of windows, and

estimating the inclination utilizing distances of the plurality of distances, the utilized distance corresponding to the extracted windows.

17. (Original) The system of Claim 16 wherein:

the controller further performs functions of;

estimating distances to the road surface respectively for the plurality of windows based on the estimated inclination, and

storing the estimated distances in a memory; and

wherein the function of extracting the windows is based on the estimated distances stored in the memory.

18. (Currently Amended) The system of Claim 15, wherein the controller further performs function of:

Alp
CON
judging, for each of the plurality of windows, based on the estimated inclination, whether the object is an obstacle or the road surface and thereby obtaining a judgment result;

recognizing the object based on the judgment result;

calculating, when the object has been judged as an obstacle, a relative speed and a relative distance between the vehicle and the obstacle utilizing the image; and

sensing possible collision with the obstacle based on at least one of the relative speed and the relative distance and performing a collision avoidance action.